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A Socio-Ecological Analysis of the Interactions Between the COVID-19 Pandemic and Health Inequalities

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FOREWORD

This publication by the National Collaborating Centre for Healthy Public Policy (NCCPPH) is intended for public health actors and decision makers who wish to incorporate equity considerations into emergency preparedness. It was produced as part of the regular scientific programming of the NCCPPH.

The publication offers ways to integrate data on health inequalities into emergency preparedness and response plans. Policymakers, health system managers, researchers, and community stakeholders are encouraged to draw on these analyses to develop policies, design interventions, and promote systemic changes that support health equity. The proposed actions have been designed to be transferable and adaptable to different contexts, ensuring their relevance and applicability at local, regional, and national levels.

We aim to highlight the vulnerabilities that the pandemic intensified or significantly affected to ensure we are better prepared to address these issues in future public health emergencies. As much as possible, we focus on the interaction between the pandemic and the vulnerabilities faced by various individuals and populations, as well as the factors contributing to health-related disparities. To facilitate the presentation of our findings, we use the socio-ecological model of health to illustrate the pandemic's impacts.

The NCCHPP is a hub of expertise and knowledge sharing in the area of healthy public policy. Its mandate is to support public health actors across Canada in their efforts to develop and promote healthy public policies. The NCCHPP fulfills this mandate by developing, synthesizing and sharing knowledge, by targeting research gaps and by fostering the development of networks connecting public health professionals, researchers and decision makers across Canada.

The NCCHPP is part of a network of six National Collaborating Centres for Public Health across Canada funded by the Public Health Agency of Canada. Its scientific programming is informed by analysis of Canada's public health actors' knowledge needs and guided by a pan-Canadian advisory committee. The NCCHPP is hosted by the Institut national de santé publique du Québec.

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1 INTRODUCTION

This publication by the National Collaborating Centre for Healthy Public Policy (NCCHPP) presents the findings of a purposive literature review on the interaction between the COVID-19 pandemic and health inequalities. Our purpose is to present the findings using the lens of a socio-ecological model (SEM) of health that attempts to account for the various levels at which existing health inequalities were impacted by the pandemic. It is our aim to help actors, and especially decision-makers, in public health consider health inequalities in their emergency preparedness plans and activities.

1.1 Background

The COVID-19 pandemic, triggered by the outbreak of the novel coronavirus, SARS-CoV-2, in late 2019, emerged as a defining global health crisis of the 21st century (Sawicka et al., 2022). Originating in Wuhan, China, the virus rapidly transcended borders, leading the World Health Organization (WHO) to declare a global pandemic by March 2020 (Cucinotta & Vanelli, 2020). As countries worldwide contended with surging infection rates, healthcare systems were overwhelmed, economies were disrupted, and daily life underwent unprecedented changes (Filip et al., 2022). The pandemic's impact extended far beyond the immediate health implications of the virus, revealing and exacerbating a complex array of health inequalities deeply embedded in societies worldwide (Bambra et al., 2020).

COVID-19's far-reaching effects underscored the multifaceted nature of health disparities, influenced by several factors, including socioeconomic status, ethnicity, gender, age, and geographic location (Bambra et al., 2020). The pandemic acted as a catalyst, exposing the vulnerabilities of disadvantaged populations and highlighting the inequities that contribute to differential health, social, and economic outcomes, among others (Green, Fernandez, & MacPhail, 2021). These inequalities manifested in various ways, from higher rates of infection and mortality in marginalized communities to unequal access to healthcare services, testing, and vaccination (Andraska et al., 2021). The interplay of these factors with the pandemic led to syndemic conditions, situations where socio-ecological factors such as poverty, racial inequality, and limited access to healthcare interact synergistically, exacerbating the spread and impact of the disease, resulting in a more devastating toll on these populations (Shelke et al., 2023).

The concept of a syndemic, initially proposed by Merrill Singer in the 1990s, is particularly relevant in understanding the COVID-19 pandemic (Singer et al., 2017). The term "syndemic" describes the synergistic interaction between biological and social factors that compound disease spread and impact (Mendenhall et al., 2022). In the context of COVID-19, this syndemic perspective is crucial for understanding how pre-existing social and health inequalities shaped the pandemic's trajectory across different communities (Apolonio et al., 2022). For instance, low-income families, often living in crowded conditions and working in essential services, faced greater exposure to the virus while having limited access to medical care (Isasi et al., 2021).

Similarly, racial and ethnic minorities experienced higher rates of morbidity and mortality, a reflection of systemic health and social inequalities (Kemei et al., 2023).

Furthermore, the global response to COVID-19, including lockdown measures, social distancing, and the rapid development and deployment of vaccines, highlighted disparities in communities' capacity to adhere to public health guidelines and access healthcare resources (Filip et al., 2022; Li et al., 2023). The digital divide became more apparent, with the shift towards online education and telehealth services disadvantaging those without access to the necessary technology (Litchfield et al., 2021). Economic impacts disproportionately affected certain sectors, exacerbating unemployment and poverty rates among the most vulnerable groups (Naseer et al., 2023).

In addressing the widespread impact of the pandemic, it is crucial to recognize that its effects extended beyond immediate health consequences, influencing social and economic aspects of life and exacerbating existing inequalities. Understanding these wide-ranging effects requires a framework that captures the complexity of human societies and the myriad factors contributing to health, social, and economic outcomes. The socio-ecological model (SEM), based on Bronfenbrenner's ecological systems theory, offers a valuable framework for analyzing these complexities (Bronfenbrenner, 1977). This model posits that health outcomes are the result of influences at multiple levels: the individual (microsystem), interpersonal relationships (mesosystem), organizational structures and community contexts (exosystem), and broader social and policy environments (macrosystem), with the addition of the chronosystem to account for the dimension of time, as these influences are woven into a myriad of complex social interactions that are both anchored in and evolve with historical movements and changes (Golden et al., 2015; Miralles et al., 2021). This approach enhances the relevance and applicability of our analysis and contributes to the broader goal of advancing health equity.

1.2 Aims and Justifications

Our study is driven by the objective of not only examining inequalities through a focus on the syndemic nature of COVID-19, but also of informing the development of novel strategies for mitigating the underlying causes of health inequalities in the context of health crises. Incorporating these insights into public policies can lead to more equitable health systems and resilient communities capable of withstanding future public health challenges. Thus, this paper is of paramount importance for guiding the creation of inclusive, healthy public policies that prioritize the needs of the most vulnerable populations, ensuring that public health responses are effective, comprehensive, and equitable. Hence, the aims of this report are to:

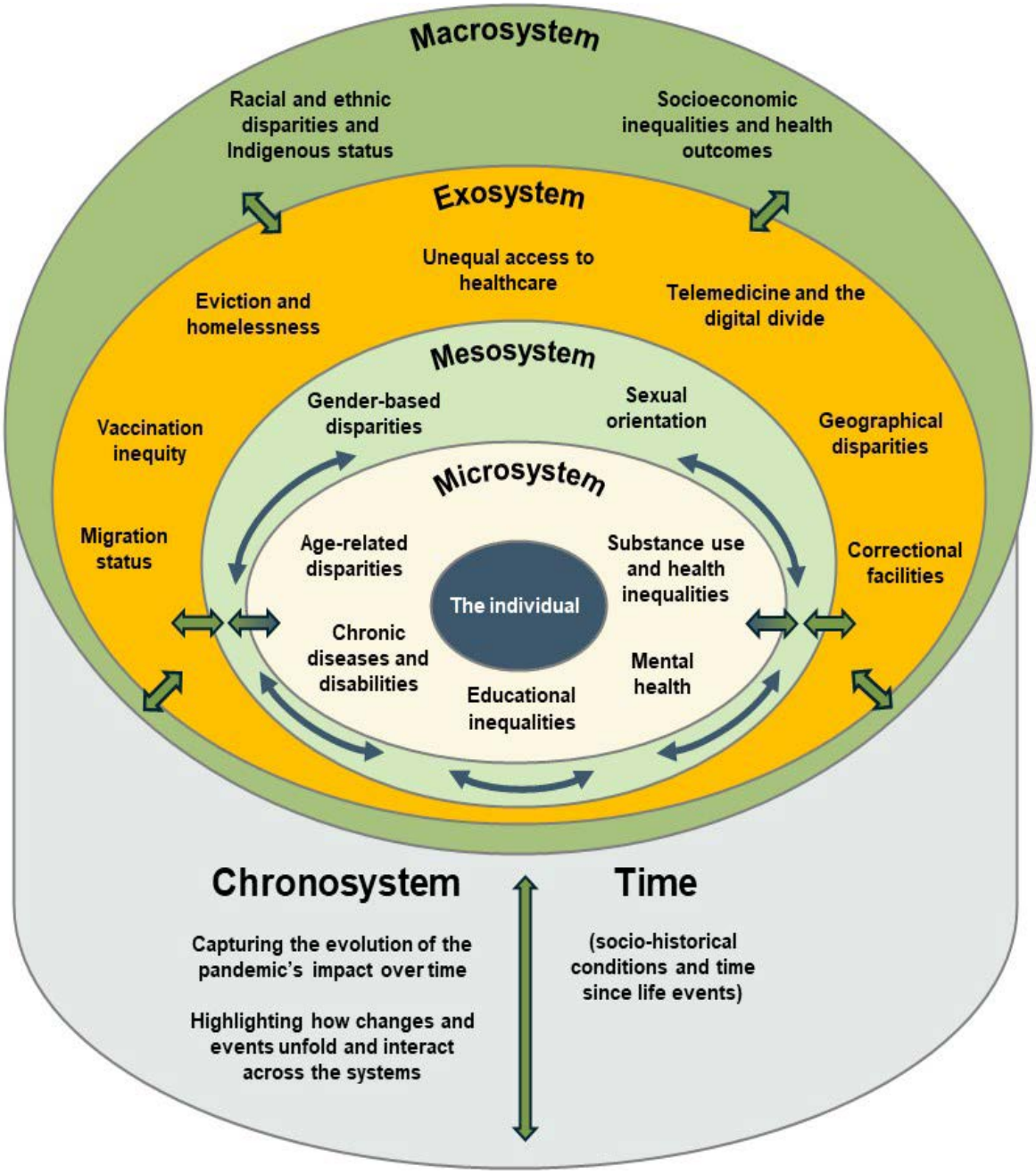
- Synthesize evidence on the syndemic impacts of COVID-19 by gathering and analyzing research that sheds light on how the COVID-19 pandemic contributed to the exacerbation of health inequalities, emphasizing the syndemic perspective.
- Provide a holistic understanding of the dynamic interactions between individual behaviours, interpersonal relationships, organizational structures, community contexts, and broader social and policy environments that contributed to health inequalities during the pandemic.

- Contribute knowledge that may be used to shape tailored and equitable public health strategies in preparation for future health crises by facilitating the development of multifaceted intervention strategies.

1.3 Rationale for Applying the Socio-Ecological Model (SEM)

To analyse the unprecedented challenges posed by the COVID-19 pandemic, it is helpful to make use of a framework that encapsulates the multifaceted and dynamic nature of health inequalities exacerbated by the crisis. The SEM was first suggested by Brofenbrenner in the 1970s as an ecological systems theory and was later redefined by McLeroy et al. as a framework for promoting health-related behavioural change (Bronfenbrenner, 1977; McLeroy et al., 1988). The SEM offers a multi-level analysis that spans a range of factors from individual behaviours to broader social policies. It enables a comprehensive exploration of the pandemic's impacts and the measures needed to mitigate its effects on diverse populations. Thus, the SEM represents a powerful tool in this context (Jones, 2022). This justification underscores the SEM's capacity to guide the development of informed, targeted, and effective public health policies that address the complex interplay of factors contributing to health disparities during the COVID-19 pandemic (Lun et al., 2022; Stokols, 1996).

Figure 1 Socio-Ecological Model of Interactions Between the COVID-19 Pandemic and Health Inequalities



Socio-Ecological Model of Interactions Between the COVID-19 Pandemic and Health Inequalities. Adapted from Bronfenbrenner's Ecological Systems Theory (Bronfenbrenner, 1977), with results derived from the present study. Licensed under Creative Commons CC-By-4.0.

1.3.1 Multi-Level Analysis for a Comprehensive View

The SEM's strength lies in its ability to provide a holistic examination of health determinants across multiple levels, from the microsystem to the macrosystem (Golden & Earp, 2012; Stokols, 1996). This approach is crucial in the context of COVID-19, where a confluence of factors, including socioeconomic status, race, ethnicity, and access to healthcare, influenced health outcomes (Centers for Disease Control and Prevention [CDC], 2024; Rozenfeld et al., 2020). The pandemic highlighted the intricate web of contributors to health inequalities, necessitating a framework like the SEM that can analyze these factors in conjunction, ensuring that interventions address the root causes of disparities and reach the most vulnerable groups effectively.

1.3.2 Interconnectedness of Health Determinants and Policy Implications

A distinctive advantage of the SEM is its focus on the interconnectedness of health determinants across different levels (CDC, 2024). The pandemic made it evident that individual health behaviours are deeply influenced by broader social norms and policies (Short & Mollborn, 2015). By facilitating an understanding of how changes at one level can affect outcomes at another, the SEM can guide the formulation of public policies that are reactive to immediate challenges and proactive in building resilience against future crises. This interconnected perspective is essential for developing comprehensive strategies to successfully mitigate the syndemic nature of public health emergencies, where social, economic, and health-related factors interact synergistically (Senterfitt et al., 2013).

1.3.3 Guiding Evidence-Based Policy Development through Temporal Dynamics

Utilizing the SEM to assess COVID-19's impact enhances evidence-based policy development by synthesizing interdisciplinary findings and identifying multi-level contributors to health disparities (Caperon et al., 2022; Committee, 2011). Incorporating the chronosystem within SEM adds a critical temporal dimension, enabling policy makers to track disparities over time and adjust interventions as contexts evolve. This temporal perspective is essential for designing policies responsive in the short term and sustainable for long-term health equity, ensuring relevance through continuous monitoring and adaptation.

2 METHODS

This study made use of a purposive literature review to strategically gather and synthesize evidence relevant to the syndemic impacts of COVID-19 on health inequalities. A focused selection of studies was used to explore key themes surrounding the pandemic, health inequalities, and policy measures. A systematic search was conducted in March 2023 across several databases, including Ovid MEDLINE, Health Policy Reference Center, and SocINDEX, using specific terms related to COVID-19 and health disparities (see Figure 1 in Appendix 1). The review focused on studies from Organization for Economic Cooperation and Development (OECD) countries, with particular attention on disadvantaged populations such as racial minorities, socioeconomically deprived groups, and other vulnerable demographics, published from 2019 to April 2023 (see Table 1 in Appendix 1). Limiting our search to OECD countries allowed us to focus on findings from economic and social contexts similar to those found in Canada. None of our findings or analysis are meant to be generalized to specific countries or contexts.

Two reviewers conducted screening and selection of articles, resulting in the inclusion of 126 studies. Data were extracted using a standardized form and analyzed through a SEM to identify patterns across multiple dimensions of health inequalities.

The detailed methodology, including the search strategy, inclusion criteria, and data extraction process, is provided in Appendix 1.

3 RESULTS

3.1 Study Characteristics

The report encompassed 126 studies that varied widely regarding study design, population, and location. The studies reviewed were carried out among racial and ethnic minorities, low-income communities, refugees and displaced persons, homeless populations, incarcerated populations, undocumented immigrants and asylum seekers, adolescents and the elderly, individuals with pre-existing health conditions, populations living in remote and rural areas, people with disabilities, 2SLGBTQI+ communities, and people with substance use disorders. Thirteen studies were published in 2020, 48 in 2021, 49 in 2022, and 16 from January to April 2023. In terms of study type and design, 86 were observational single studies, 27 were syntheses (1 meta-analysis, 24 scoping reviews, two systematic reviews), one combined synthesis and a single study approach, and 12 were editorial and opinion pieces. Concerning their geographical location, there was representation from countries belonging to Asia, America, Europe, and Australia. However, studies from the United States of America dominated the review, followed by the UK, Australia, Canada, China, Italy, Mexico, Chile, Switzerland, Brazil, Denmark, Indonesia, South Korea, Netherlands, Portugal, Spain, Sweden, and Vietnam.

A Note on Terms

The publications that we present in this review use a variety of terms to describe the differences in relative advantage of population groups as it relates to health, generally, and the COVID-19 pandemic, specifically. At the NCCHPP, we most commonly use health inequalities to discuss differences in health and social outcomes between groups but other commonly used terms such as health disparities or health inequities, appear frequently in the documents we examined, often without an explicit definition. For this reason, we have attempted to incorporate this variety so as not to impute meaning to other authors (by, for example, adopting a single term which was not used uniformly). This is also the case for some terms used to differentiate between categories as these sometimes change in different contexts (for example, Hispanic is more commonly used as an ethnic or racial category in the United States than it is in Europe; or while 2SLGBTQI+ is now commonly used in Canada, it is not necessarily used elsewhere and it may not be used consistently – some studies, for example, refer to men who have sex with men while others use gay or LGBT). We have done our best to use these terms in ways that are consistent with the documents under study and hope that this strikes a balance between clarity and accuracy.

3.2 Health Inequalities Through the SEM: Levels, Dimensions, and Key Findings

In this section, we present a detailed exploration of the complex nature of health inequalities, which were significantly exacerbated by the COVID-19 pandemic. We delve into each level of the SEM— microsystems, mesosystems, exosystems, macrosystems, and chronosystems— to examine the distinct dimensions of health inequalities. This analysis not only maps out the intricate web of health inequalities during the pandemic but also emphasizes the interdependencies across different levels contributing to the syndemic nature of COVID-19. We systematically highlight the various levels at which these inequalities were manifested, from the direct, personal interactions within microsystems to the overarching influences of social norms and policies encapsulated by macrosystems.

Throughout this report, we attempt to capture the complex layers and dimensions of health inequalities within the SEM by accounting for how they are impacted at each level of the model. While this may lead to the appearance of some repetition, it allows us to conceptually separate how different dimensions operate individually and in conjunction with other factors at and between each level. By revisiting themes across SEM levels—microsystems, mesosystems, exosystems, macrosystems, and chronosystems—and within specific dimensions at each level, we underscore the depth and interdependency of health inequalities. This approach highlights how individual, interpersonal, community, and social influences intersect to shape health outcomes and allows us to analyze recurring patterns within each dimension. By layering the descriptions, we can offer a comprehensive and multidimensional view of how foundational inequalities interact dynamically with systemic factors, providing insight into critical intervention points. This method highlights the pervasive and syndemic nature of health inequalities exacerbated by the COVID-19 pandemic, emphasizing the immediate and cumulative effects across different levels and dimensions.

3.2.1 The Microsystems (individual environments)

The microsystems, as the innermost layer of the socio-ecological model, include the intimate environments where individuals engage directly with family, friends, healthcare providers, and other personal networks (Bronfenbrenner, 1977; McLeroy et al., 1988). Within this sphere, the COVID-19 pandemic most tangibly altered the fabric of daily life, unveiling and intensifying health inequalities. Here, we explore how this crisis touched the lives of various groups, from the heightened vulnerabilities faced by older adults to the unique challenges confronting younger populations and those with chronic diseases or disabilities. As we delve into the microsystem, we reveal the intricate connections between personal experiences and broader societal shifts that shaped health outcomes during the pandemic.

It is essential to recognize that individuals exist within multiple microsystems that interact with one another, further compounding the impacts of health inequalities. These interactions among microsystems create a network of influences that shape individual experiences more dynamically, demonstrating how the pandemic's effects resonated not only within single environments but also across multiple interconnected microsystems.

3.2.1.1 Age-Related Disparities

The COVID-19 pandemic illuminated age-related health inequalities, affecting both extremes of the age spectrum, from the older to the younger generations. Each generation faced unique challenges within the microsystem of the socio-ecological model.

Impacts on Older Adults

- Physical and Mental Health Risks

Long-term care residents, in particular, experienced deteriorations in cognitive, behavioural, and physical health due to the reduction in visits and in-person engagement. The decrease in physical and social activity contributed to these declines (Chen et al., 2021). Despite these challenges, the pandemic period also saw an increase in the use of digital literacy and telemedicine. This trend offered a glimpse of new possibilities for healthcare delivery for aging populations, although the availability and effectiveness of such interventions varied across different social contexts (Chen et al., 2021).

- Socioeconomic Vulnerabilities

The pandemic magnified existing vulnerabilities among older populations, with differential risks arising from pre-existing inequalities. Older women, particularly those facing poverty in old age and those with lower educational attainment, were notably affected. These women often faced cumulative disadvantages throughout their lifetimes, including lower wages, interrupted careers

due to caregiving responsibilities, and reduced access to pensions, leaving them financially insecure in old age (Lee, 2020). The pandemic exacerbated these challenges by further limiting their access to essential services, including healthcare and social support networks. Additionally, income inequalities and structural shifts in the labour market, such as the transition to remote work and economic shutdowns, disproportionately affected older women who lacked digital literacy or were employed in precarious sectors, thereby placing them at greater risk (Lee et al., 2021). These compounded effects resulted in higher rates of mental distress and increased vulnerability to health complications (Borelli et al., 2022).

- Psychosocial Wellbeing

The pandemic highlighted significant psychosocial health inequities among older adults. One of the main issues was the reduction in social networks and the inability to engage in routine social activities, leading to increased mental distress. The enforced isolation aimed at preventing the spread of the virus also led to a rise in loneliness and, in certain cases, worsened conditions of neglect and violence within homes (Borelli et al., 2022). These psychosocial effects were particularly pronounced among vulnerable older populations with limited access to external support.

Alongside these issues, there was also a noticeable erosion of institutional trust, as older adults perceived certain public health responses as inadequate or inconsistent. This erosion impacted their confidence in healthcare systems, contributing to a sense of abandonment and heightened psychological stress (Lee et al., 2021). The role of cocooning in increasing social withdrawal and mental health challenges was also evident, as older individuals experienced greater loneliness during these periods of isolation (Chen et al., 2021). While cocooning was intended as a protective measure, its unintended effects on mental health emerged as a point of concern.

The pandemic also coincided with a rise in suicide rates, alongside increasing feelings of helplessness and reduced access to social support (Borelli et al., 2022). Measures such as physical activity, digital literacy programs, and mental health support services were introduced in response. However, the long-term impact of these strategies on older adults' mental health remains a subject of ongoing observation and analysis (Seckman, 2023).

Research has indicated notable differences in emotional stability between older and younger populations during the pandemic. Despite older adults often exhibiting greater emotional resilience, they faced unique psychosocial challenges related to the disruption of social networks and prolonged isolation (Seckman, 2023). These differences underscored the importance of considering the specific needs of various age groups when addressing the psychosocial impacts of the pandemic.

Studies of the lived experiences of older adults during the initial lockdowns revealed feelings of ambivalence and, at times, resentment toward public health measures. Many older individuals reported feeling stigmatised and isolated, which further impacted their well-being (Falvo et al.,

2021). Studies have suggested that engaging these populations in bi-directional communication could enhance the effectiveness of public health measures and better address their psychosocial needs (Falvo et al., 2021). Additionally, the pandemic highlighted the essential role of informal caregivers, particularly in low-income settings, in supporting the well-being of older adults and mitigating the effects of isolation (Madia et al., 2023).

- Health Disparities and Vaccination

Studies have shown that older individuals residing in multi-generational households, particularly within certain ethnic minority groups, faced an increased risk of COVID-19 mortality (Nafilyan et al., 2021). The disparities in vaccination rates among older adults, notably those living in poverty or without a high school diploma, point to the urgency of addressing these inequities through targeted health policy initiatives (Wang et al., 2021).

Impacts on Youth and Young Adults

- Educational and Economic Challenges

The pandemic also exacerbated existing vulnerabilities for disconnected youth and young adults, particularly those not in employment, education, or training (NEET). Economic shutdowns led to job losses, particularly in sectors like hospitality and retail, where many NEET individuals were employed (Nelson et al., 2020). The switch to online education and training posed significant barriers, especially for those without access to technology, increasing the risk of long-term disconnection from the labour market and educational opportunities (Palmer & Small, 2021).

- Social and Sexual Development

Younger populations, including adolescents and young adults, encountered drastic changes in their social dynamics. Physical distancing and lockdowns severely reduced in-person social and sexual encounters, which are critical aspects of social and sexual development (Nelson et al., 2020). Studies found that while physical interactions decreased, there was a rise in solitary sexual behaviours and virtual sexual engagements, bringing about new challenges in sexual health and safety (Nelson et al., 2020). The necessity for virtual socialization during the pandemic highlighted disparities in access to technology and safe virtual spaces, further exacerbating feelings of isolation and impacting mental health (Nelson et al., 2020).

Racial and Ethnic Disparities in Age-Related Health Impacts

- Impact on Older Adults of Colour

Racial and ethnic disparities were also stark. For example, in the US, American Indian and Alaska Native adults faced higher COVID-19 case and hospitalization rates compared to other races, highlighting the compounded effect of existing health inequalities (Hicks et al., 2023). The disproportionate impact on older adults of colour was evident, with factors such as multi-generational living conditions contributing to elevated mortality risks (Nafilyan et al., 2021). Addressing these disparities requires a focus on culturally appropriate health interventions (Hicks et al., 2023).

- Psychosocial Well-being and Health Disparities

The pandemic amplified health risks for disconnected youth and young adults, particularly those not in employment, education, or training (Palmer & Small, 2021). Economic instability and barriers to online education further marginalized these groups, necessitating robust social safety nets (Palmer & Small, 2021). The impact on sexual minority adolescents was notable, with reduced physical interactions leading to increased virtual engagements and mental health challenges (Nelson et al., 2020). In one case, the authors suggested that providing access to resources sensitive to this population's social and sexual health needs is crucial during such crises (Nelson et al., 2020).

The COVID-19 pandemic exposed significant age-related health disparities, impacting both older and younger populations in distinct ways. While older adults faced heightened risks of social isolation, mental health decline, and physical vulnerability, younger generations experienced disruptions in social development, education, and employment.

3.2.1.2 Chronic Diseases and Disabilities

The presence of chronic disease and disabilities was also a significant factor in determining the impacts of the pandemic within the microsystem. Living with either or both contributed to worse outcomes related both to COVID-19 and to underlying conditions. Here, we present some of the ways that the research has shown that having a chronic disease or living with a disability interacted with the pandemic.

Immunocompromised Populations and COVID-19 Risks

The pandemic acutely highlighted health disparities among immunocompromised patients, including those with cancer, organ transplants, HIV, chronic inflammatory diseases, and genetic immunodeficiencies, along with individuals suffering from kidney and liver diseases (Moss et al., 2022). These groups, already vulnerable due to their underlying conditions, faced compounded risks from COVID-19, necessitating a deeper understanding of the disease's trajectory and the nuanced efficacy, safety, and benefit-risk profiles of COVID-19 vaccines (Moss et al., 2022). Based on the included studies, recorded data and national health authority recommendations underscored the urgent need for tailored vaccination strategies that consider the unique challenges these populations encounter, especially in light of potential waning immunity and emerging SARS-CoV-2 variants (Moss et al., 2022).

Structural Racism and Chronic Disease Inequities

The intersection of healthcare with environmental and socioeconomic factors was pronounced, with structural racism playing a pivotal role in perpetuating inequities in conditions like hypertension, a health disparity prevalent in many countries. The rapid shift to virtual healthcare platforms, catalyzed by the pandemic, has exacerbated the existing racial healthcare divides, especially affecting wealth-disadvantaged communities, geographical minorities, and those with lower education levels (Bress et al., 2021). Deteriorating blood pressure control rates, particularly in communities of colour and in places without universal coverage, highlighted the critical need

for enhanced hypertension awareness, lifestyle interventions, and access to evidence-based pharmacotherapy. Community-based interventions and initiatives enabling self-monitoring of blood pressure stood out as essential tools for fostering patient trust and engagement in healthcare (Bress et al., 2021).

Long-Term Care and Intellectual Disabilities

Persons in long-term care, particularly those with intellectual disabilities, carried a disproportionate burden during the COVID-19 pandemic (Koks-Leensen et al., 2023). Data collected from care facilities revealed that, while infection rates mirrored those in the broader population, the case-fatality rates were significantly higher for individuals with intellectual disabilities, particularly those over 40 and those with Down syndrome or multiple concurrent health conditions (Koks-Leensen et al., 2023).

The COVID-19 pandemic amplified the vulnerabilities of individuals with chronic diseases and disabilities, worsening their health outcomes. The compounded risks from both the virus and underlying conditions highlighted the need for tailored healthcare approaches, including targeted vaccination strategies and improved access to care, especially for disadvantaged communities.

3.2.1.3 Educational Inequalities

In the literature we examined, educational differences had a significant impact on the way the pandemic and the measures adopted to mitigate its effects were understood. Once again, inequalities in educational attainment, at the individual level, were shown to result in different outcomes for differently advantaged groups.

Educational Attainment and Preventive Behaviours

According to a study conducted between June and December 2021 across 90 countries, approximately 89.9% of individuals believed in the effectiveness of social distancing and mask-wearing as preventive measures against the spread of COVID-19. However, this belief and the practice of these preventive behaviours were not uniformly distributed among different educational levels (Kirkby et al., 2022). Specifically, individuals with higher levels of education were more likely to believe in the effectiveness of these measures and to practice them consistently, while those with lower educational attainment were less likely to adhere to such preventive behaviours. This disparity suggests that educational attainment played a critical role in influencing both the perception and implementation of public health measures during the pandemic.

Disparities in Mask Usage and Social Distancing

Other data revealed a significant disparity in mask usage, with more frequent application among those with higher educational backgrounds (Kirkby et al., 2022). In wealthier nations, social distancing was paradoxically more prevalent among individuals with lower educational attainment when compared to their higher-educated counterparts after controlling for other factors (Kirkby et al., 2022).

Remote Learning Challenges

Remote learning during the pandemic also highlighted educational inequalities. Student perspectives on remote learning varied significantly, with low-SES students, girls, and those living in rural areas facing greater challenges in accessing and using technology effectively. However, despite these disparities, there were fewer inequalities in perceptions of teacher effectiveness across different socioeconomic groups. Schools in many countries provided several supports to improve remote learning quality, which mitigated some of the inequalities (Kennedy et al., 2022).

Learning Gaps and Low-Achieving Students

The COVID-19 pandemic also exacerbated educational inequalities through school closures, which had a disproportionate impact on low-achieving students. In Germany, for example, low-achieving students experienced a more significant reduction in learning time. They were more likely to engage in activities detrimental to their development, such as watching TV or playing computer games. This learning gap was not adequately addressed by parental or school support, further disadvantaging low-achieving students (Grewenig et al., 2021).

These findings illuminate the complex relationship between educational attainment and adherence to COVID-19 preventive behaviours, underscoring the need for targeted public health messaging and interventions that bridge the educational divide to enhance the effectiveness of pandemic response strategies.

3.2.1.4 Mental Health

The COVID-19 pandemic significantly exacerbated mental health issues across various population groups, particularly those already vulnerable due to social discrimination, lack of support, or pre-existing mental health conditions. The stressors of the pandemic, such as isolation, fear of infection, and disruptions to routine support structures, compounded these vulnerabilities, leading to heightened levels of anxiety, depression, and loneliness (Moreno-Agostino et al., 2023; Nilsson et al., 2022; Parenteau et al., 2022). These mental health challenges were observed across different intersectional categories, with pronounced effects on marginalized and underserved groups.

Impact on Marginalized Groups

Various marginalized groups were disproportionately affected by the pandemic's mental health toll, reflecting the intersectionality of race, socioeconomic status, sexual orientation, and more. For many of these populations, the pandemic intensified existing challenges, further straining already fragile support systems.

- Racial and Ethnic Minorities

The pandemic exposed deep-seated inequalities in mental health outcomes among racial and ethnic minorities, particularly those in lower socioeconomic positions. Limited access to mental health resources, compounded by structural factors such as residential segregation and reduced healthcare accessibility, worsened outcomes for these groups (Nilsson et al., 2022; Parenteau et al., 2022; Pavani et al., 2021). Immigrant and migrant communities were particularly vulnerable, as fears surrounding job security, health risks, and lack of social support systems exacerbated stress and mental health issues (Kamal et al., 2021; Kang et al., 2021; Pineros-Leano et al., 2022).

- Young Adults and LGBTQ+ Communities

Younger populations, particularly those identifying as 2SLGBTQI+, faced a disproportionate mental health burden during the pandemic. The heightened vulnerability of these groups underscores the role of immediate social environments, both supportive and detrimental, in influencing mental health disparities. Many of these individuals reported significant increases in anxiety, depression, and loneliness, with social isolation and the disruption of critical support networks amplifying these effects (Kamal et al., 2021; Levandowski et al., 2022; Na et al., 2022).

- People with Disabilities

People with disabilities faced unique challenges during the pandemic, particularly regarding access to healthcare and support services. These barriers compounded their stress and mental health struggles, highlighting the need for more inclusive public health strategies (Kang et al., 2021; Levandowski et al., 2022; Tran-Chi et al., 2021).

Socially Marginalized and Psychiatrically Vulnerable Individuals

Socially marginalized individuals, particularly those experiencing homelessness or with severe mental illnesses, were found to be at significantly higher risk of adverse outcomes, including elevated levels of mental distress and heightened susceptibility to infection and hospitalization due to COVID-19 (Nilsson et al., 2022). Those in precarious living situations faced higher exposure to mental health challenges, which underscores the crucial role of housing stability and healthcare accessibility during crises.

Men who have sex with men and Transgender People

In certain regions, such as Indonesia, men who have sex with men (MSM) and transgender individuals reported high levels of psychological distress, compounded by social stigma and the challenges of accessing support services. The intersection of sexual identity and social discrimination further exacerbated these mental health disparities, underscoring the importance of tailored support systems for these populations (Septarini et al., 2021).

Impact on Families and Caregivers

The mental health impact of the pandemic extended beyond individuals to entire family units, particularly affecting caregivers and those responsible for homeschooling during lockdowns.

- Children and Adolescents

Children and adolescents experienced significant mental health strain due to the shift to remote schooling and the disruption of peer interactions. Parents and caregivers faced the added responsibility of managing both education and mental health support for their children, with women often disproportionately bearing the caregiving burden (Bravo-Sanzana et al., 2022; Heers & Lipps, 2022; McMellon & MacLachlan, 2021). This increased strain on families, particularly those from lower-income backgrounds, highlighted the need for more comprehensive support systems.

- University Students

University students, especially those living alone, faced increased levels of stress during the pandemic. Isolation, coupled with challenges in accessing professional help, led to heightened mental health issues, further exacerbating the existing vulnerabilities of this group (Tran-Chi et al., 2021).

Older Adults

Older adults were particularly vulnerable to the mental health impacts of the pandemic, with issues such as loneliness, reduced support networks, and increased suicide rates emerging as significant challenges (Borelli et al., 2022). The long-term effects on this population have been profound, with marked differences in emotional resilience and coping mechanisms compared to younger age groups (Seckman, 2023). Studies of the lived experiences of older adults during lockdown revealed feelings of ambivalence and stigma related to public health measures, which often left them feeling isolated and marginalized (Falvo et al., 2021).

The role of informal caregivers became crucial during this period, particularly for older adults in low-income groups, where access to formal support services was limited. Engaging older adults and their caregivers in two-way communication was highlighted as a critical factor in tailoring public health responses to better meet their needs (Madia et al., 2023).

Broader Societal Impact

The mental health disparities observed during the pandemic highlight the complex interplay of multiple social determinants of health, including race, socioeconomic status, and access to care. These factors often intersected in ways that exacerbated vulnerabilities, particularly for marginalized and underserved communities (Kamal et al., 2021; Moreno-Agostino et al., 2023; Pineros-Leano et al., 2022). Given this dynamic, the pandemic not only exposed existing inequalities but also deepened them, underscoring the need for comprehensive policies that address the mental health needs of all populations.

In conclusion, the mental health challenges posed by the pandemic were not evenly distributed across society. Marginalized groups, including racial and ethnic minorities, LGBTQ+ communities, people with disabilities, and socially vulnerable individuals, faced heightened levels of distress, which reflected broader social inequalities. Moving forward, there is a pressing need for public health measures that focus on inclusivity and mental health equity to ensure that vulnerable populations receive the support they need to recover from the long-term effects of the pandemic (Parenteau et al., 2022).

3.2.1.5 Substance Use and Health Inequalities

The COVID-19 pandemic exacerbated existing health inequalities, particularly among individuals with substance use disorders. These inequalities manifested predominantly at the microsystem level, where individuals experienced direct impacts on their health, well-being, and access to essential services. Understanding these effects is crucial for developing targeted interventions that address the specific challenges faced by this vulnerable population.

Disruptions to Lives and Mistrust in Healthcare

During the pandemic, people with substance use disorders faced severe disruptions to their lives that often overshadowed concerns about the direct health effects of COVID-19. One study highlighted significant adverse effects on participants' mental health, financial stability, and the quality of substances they used, with these impacts frequently taking precedence over fears related to the virus itself (Rains et al., 2022). Skepticism about the severity of COVID-19, particularly among unvaccinated individuals, was prevalent within this group, driven by a general mistrust of healthcare and governmental institutions. This mistrust was exacerbated by past experiences of stigmatization (Rains et al., 2022). Despite these challenges, local Harm Reduction (HR) organizations were consistently seen as trustworthy. Participants were willing to engage with low-threshold healthcare services, including COVID-19 vaccinations, when offered through these HR facilities (Rains et al., 2022).

Integration of Harm Reduction Programs

The pandemic's wide-reaching effects required healthcare services to integrate with harm reduction programs and utilize alternative distribution channels, such as community organizations and non-traditional suppliers, to maintain participation in vaccination and other healthcare initiatives for individuals with substance use disorders (Rains et al., 2022). The unique

needs of this community, comprising individuals struggling with substance use, often compounded by poverty or homelessness, underscored the importance of adopting a more inclusive healthcare engagement approach. Addressing the barriers faced by these individuals, particularly their limited access to primary healthcare resources, became increasingly urgent during the pandemic (Kouimtsidis et al., 2021; Rains et al., 2022).

Service Delivery Challenges Due to Social Distancing

Social distancing measures implemented during the pandemic led to substantial changes in how substance use services were delivered at the microsystem level. The cessation of structured group work, community detoxification programs, and the drastic reduction of in-person consultations significantly disrupted the support available to individuals (Kouimtsidis et al., 2021). These changes disproportionately affected the most vulnerable, such as those experiencing homelessness or unemployment, who often lacked the technological means to access online services. As a result, many individuals were left isolated and without the critical support they needed, further exacerbating their mental health challenges (Kouimtsidis et al., 2021).

Mental Health Risks and Tailored Interventions

The heightened mental health risks during the pandemic were particularly pronounced for those with pre-existing mental health conditions or Alcohol Use Disorders (AUDs). The stressors of potential infection, financial strain, and the risk of relapse created an environment of heightened psychological distress. Tailored support and intervention strategies are essential to navigating the compounded effects of a pandemic on substance use and the associated health disparities at the microsystem level (Kouimtsidis et al., 2021; Rains et al., 2022).

This synthesis of diverse perspectives and findings underscores the multifaceted impact of the COVID-19 pandemic on substance use and health inequalities within the microsystem. A focus on the innermost level of individual experiences and the immediate environment, clearly indicates that many of the most significant impacts can be effectively addressed through targeted interventions at this level. These efforts are crucial for reducing deep-rooted disparities and improving health outcomes for individuals with substance use disorders (Kouimtsidis et al., 2021; Rains et al., 2022).

3.2.2 The Mesosystems (interpersonal and inter-group relationships)

The mesosystems provide a crucial lens through which to explore how different microsystems, individual environments such as family, healthcare, and educational settings, interact with each other (Bronfenbrenner, 1977; McLeroy et al., 1988). While each microsystem represents a direct, personal environment in which individuals engage, the mesosystems capture the connections and interdependencies between these microsystems. Our findings specifically highlight how factors such as gender and sexual orientation intersect within these interconnected systems, where personal environments meet broader community and societal influences, further exacerbating health inequalities. Through the mesosystem lens, we gain a comprehensive view of how the overlapping influences of different microsystems shape and amplify disparities.

3.2.2.1 Gender-Based Disparities

At the level of the mesosystem, gender-based inequalities were significantly impacted by the pandemic. Below, we discuss some of the disparities presented in the literature.

Sexual and Reproductive Health Inequities

The COVID-19 pandemic intensified gender-based health disparities, particularly in the sphere of sexual and reproductive health (SRH) (Nandagiri et al., 2020). Pre-existing inequities in access to healthcare services, such as abortion and contraceptive care, were exacerbated by the pandemic's strain on healthcare systems and supply chains (Nandagiri et al., 2020). This strain has been termed "structural violence," reflecting the embedded and historical injustices that disproportionately affect women across various social stratifications, including race, ethnicity, age, class, gender, and sexual identity (Nandagiri et al., 2020). The chronosystem perspective highlights how these disparities have evolved over time, influenced by historical events and socio-temporal changes such as shifts in public health policies and economic recessions. Additionally, intersectionality underscores how multiple social identities intersect to produce unique experiences of oppression and privilege. The pandemic-induced lockdowns and quarantine measures led to a surge in intimate partner violence, complicating support for pregnancies and access to SRH services, further stratifying health outcomes along gender lines (Guerrina et al., 2021; Mattsson et al., 2023; Nandagiri et al., 2020)

Intersection of Racism and Sexism

With regard to Black women, the intersection of racism and sexism uniquely positioned them at a higher risk of COVID-19 infection and its severe outcomes (Obinna, 2021). This demographic already faces a higher prevalence of comorbidities, such as obesity and hypertension, which are exacerbated by social determinants like economic instability and healthcare access issues (Obinna, 2021). The pandemic highlighted the need for targeted interventions that address these underlying social determinants of health and mitigate the compounded impacts of systemic racism and sexism (Obinna, 2021).

Food Insecurity and Vulnerable Mothers

Food insecurity, heightened by the pandemic, was particularly detrimental to pregnant women and mothers of young children (Azevedo et al., 2023). Key socioeconomic determinants, such as ethnicity, low education, and income levels, along with mental health disorders and domestic violence, played a significant role in this crisis (Azevedo et al., 2023). The pandemic underscored the role of public policies that ensure food security and support the physical and mental well-being of vulnerable groups, especially in times of global health crises (Azevedo et al., 2023).

Women in Healthcare and Caregiving Roles

Frontline healthcare workers, predominantly women, with about 70% of the health and social workforce being female, faced increased exposure to the virus, (Su et al., 2022). Older women, particularly those in nursing homes, were also disproportionately affected due to their heightened vulnerability to severe COVID-19 outcomes and the increased burden of domestic violence during the pandemic (Su et al., 2022). Furthermore, women as unpaid informal caregivers bore the additional mental health burdens imposed by caregiving responsibilities, which were intensified by pandemic safety measures (Bilodeau et al., 2021; Su et al., 2022).

Homelessness and Gender Inequalities

The pandemic also revealed the challenges faced by homeless women in Stockholm, Sweden, where the dual crises of homelessness and COVID-19 intersected to exacerbate social isolation, poverty, and health risks (Mattsson et al., 2023). This highlights the importance of addressing the social determinants of health and committing to ending homelessness as a global health priority (Mattsson et al., 2023).

Broader Impacts and Policy Implications

In summary, the COVID-19 pandemic not only surfaced but also amplified gender-based disparities in health, and the mesosystem lens of the SEM indicates how these disparities were shaped by the interaction between individual behaviours and the broader social, community, and institutional structures (Guerrina et al., 2021; Hawkes & Buse, 2021). The gendered distribution of labour, particularly in healthcare roles, and the social norms and expectations around caregiving significantly influenced the health outcomes for women during the pandemic, necessitating an urgent call for gender-sensitive policy responses and research (Guerrina et al., 2021; Hawkes & Buse, 2021).

Examples of Pandemic-Induced Gender Inequities

- Mental Health Distress: Lockdown policies in Victoria, Australia generated and perpetuated avoidable inequities, harming mental health, as demonstrated through increased psychological distress, particularly for women (Brucki et al., 2023).
- Menstrual Product Insecurity: The pandemic-related economic impact also led to menstrual product insecurity, particularly for populations experiencing income loss, lower income, and low educational attainment (Sommer et al., 2022). Provision of free or subsidized menstrual

products is needed to support vulnerable populations and those most impacted by the economic downturn caused by the pandemic (Sommer et al., 2022).

In these and other ways, we see the interaction between existing gender-based inequalities and the pandemic. Women, in general, were impacted by the pandemic and the mitigating measures in ways that often increased their vulnerability, and this was especially true for women in multiple positions of social disadvantage, illustrating how these disadvantages intersect at the mesosystem level.

3.2.2.2 Sexual Orientation

The COVID-19 pandemic shed light on existing health inequalities, strikingly highlighting the vulnerabilities within 2SLGBTQI+ communities (Adamson, Lett, et al., 2022; Salerno et al., 2020). The intersection of sexual orientation with pandemic-induced stressors revealed and intensified systemic disparities in health access and outcomes (Juan Carlos et al., 2023; Ormiston & Williams, 2022)

Mental Health Challenges in 2SLGBTQI+ Communities

Studies indicate that 2SLGBTQI+ communities faced disproportionate mental health challenges, exacerbated by social isolation, existing stigmas, and inequities in healthcare access (Adamson, Lett, et al., 2022; Quathamer & Joy, 2022). For 2SLGBTQI+ individuals, especially youth and older persons, the pandemic often meant confinement in non-affirming environments, severing crucial support networks and access to mental health services traditionally provided by educational institutions and community groups (Adamson, Hanley, et al., 2022; Ormiston & Williams, 2022). The abrupt transition to remote living left many without essential care and support, elevating the risks of depression, anxiety, and suicidality (Salerno et al., 2020; Souleymanov et al., 2022).

Financial Strain and Economic Vulnerabilities

Financial strains were particularly acute for 2SLGBTQI+ persons, with a significant portion reporting an inability to meet basic needs due to income loss (Adamson, Lett, et al., 2022; Souleymanov et al., 2022). The precarious economic position of many in this community, combined with healthcare system shortfalls, led to skipped meals and the fear of losing health insurance in some cases, further compounding their distress (Harkness et al., 2021; Sommer et al., 2022)

Lack of Tailored Public Health Interventions

Health interventions during this time often failed to address or even acknowledge the unique challenges faced by the 2SLGBTQI+ population (Juan Carlos et al., 2023; Sousa et al., 2020). The lack of tailored public health strategies meant that many individuals did not receive the comprehensive care they required (Adamson, Lett, et al., 2022; Salerno et al., 2020). The need to recognize the specific needs of 2SLGBTQI+ persons and create ameliorative approaches that encompass financial, mental, and healthcare support emerges strongly from the literature we examined (Harkness et al., 2021; Souleymanov et al., 2022).

Resilience and Community Solidarity

The pandemic also illuminated the strength and resilience within the 2SLGBTQI+ community (Adamson, Lett, et al., 2022; Quathamer & Joy, 2022). Despite facing numerous hardships, there was a rallying of support, showcasing the solidarity and collective care that exist among populations with diverse sexual orientations (Adamson, Lett, et al., 2022; Ormiston & Williams, 2022). However, to translate this communal resilience into lasting well-being, it is important to integrate the insights gained into public health policies and interventions, ensuring that they are inclusive and equitable (Salerno et al., 2020; Sousa et al., 2020).

This enhanced awareness and understanding of the complex ways in which sexual orientation intersects with health disparities is essential for informing future public health strategies (Harkness et al., 2021; Juan Carlos et al., 2023). It provides a critical opportunity to re-evaluate and improve the systems that have historically marginalized 2SLGBTQI+ individuals, ensuring equitable healthcare access and fostering a more inclusive society post-pandemic (Adamson, Lett, et al., 2022; Ormiston & Williams, 2022).

3.2.3 The Exosystems (organizational structures and community contexts)

The exosystem encompasses broader environments that, while not directly involving individuals in immediate interactions, indirectly shape their experiences through influences like public policies, healthcare system structures, and workplace conditions (Bronfenbrenner, 1977; McLeroy et al., 1988). Unlike the direct, personal exchanges within microsystems or the interconnections among them in mesosystems, the exosystem represents the larger structural forces that impact groups and individuals from a distance. Disparities at this level often emerge from the uneven effects of public health measures or policies, which can advantage certain populations while placing others at greater risk. By examining these broader, indirect influences, we can better understand how policies and structural conditions contribute to health inequalities that permeate down through the mesosystems and microsystems, compounding the challenges faced by individuals and communities.

3.2.3.1 Unequal Access to Healthcare

The COVID-19 pandemic revealed glaring inequities in healthcare access, disproportionately affecting vulnerable populations such as refugees, migrants, asylum seekers, and individuals with lower socioeconomic status (Immordino et al., 2022a). These systemic disparities were evident across multiple dimensions, from resource allocation to healthcare infrastructure inadequacies.

Barriers to Personal Protective Equipment (PPE) Distribution

Access to PPE was a critical issue during the pandemic, particularly for marginalized communities and healthcare providers in under-resourced settings. Lower-income countries and economically disadvantaged areas within wealthier nations struggled to secure PPE, leading to heightened dissatisfaction among healthcare workers. For instance, in regions with fragmented supply chains, healthcare providers reported reusing disposable masks, an unsafe practice borne out of necessity (Chen et al., 2022; Vazquez et al., 2021). These shortages disproportionately affected frontline workers in rural or economically marginalized urban centers, amplifying their vulnerability to infection.

Structural Challenges in Healthcare Access

Systemic barriers to healthcare access, including financial insecurity, language barriers, and mistrust in healthcare institutions, were exacerbated during the pandemic. Refugees and asylum seekers often faced administrative hurdles, such as lack of documentation, which limited their ability to access essential healthcare services. Additionally, in many low-income areas, overburdened healthcare facilities and inadequate staffing levels reduced the quality and availability of care. These challenges mirrored global inequities, as high-income countries were often better equipped to address the pandemic's demands (VanWormer et al., 2023).

The pandemic highlighted critical weaknesses in global healthcare systems. Mitigating these disparities requires a multifaceted approach, including equitable resource distribution, culturally sensitive outreach programs, and sustained investments in healthcare infrastructure to support underserved populations.

3.2.3.2 Vaccination Inequity

The COVID-19 vaccination rollout served as a stark reminder of systemic inequities in global healthcare. Disparities in vaccine access and uptake reflected broader logistical, social, and economic challenges.

Logistical and Structural Barriers

Vaccination campaigns were hindered by logistical challenges, including limited availability of vaccination sites, complex appointment systems, and inadequate outreach to remote or marginalized populations. For instance, rural areas with few healthcare facilities faced significant delays in vaccine delivery, leaving vulnerable populations unprotected for extended periods (Chen et al., 2022; Cole, 2021). Immigrants and asylum seekers, particularly those without proper documentation, struggled to access vaccines due to legal and administrative barriers.

Misinformation and Vaccine Hesitancy

Misinformation regarding vaccine safety and efficacy was a significant obstacle to vaccination efforts. Social media platforms played a prominent role in disseminating myths, which were compounded by historical mistrust in healthcare systems, especially among marginalized groups. For example, communities with a history of medical exploitation or neglect often viewed vaccination campaigns with suspicion, slowing uptake despite increased risks of severe COVID-19 outcomes (Kirksey et al., 2021; Langwerden et al., 2023).

Vulnerable Populations and Prioritization

Certain high-risk groups, such as cancer patients, were inadequately prioritized during early vaccination campaigns, leaving them exposed to severe health outcomes. Similarly, refugees and migrants faced significant barriers, including language obstacles and limited transportation options, which further limited their access to vaccines. This uneven prioritization revealed critical gaps in public health planning and underscored the need for inclusive strategies (Prasad et al., 2022; Immordino et al., 2022b).

Vaccination inequities reflected systemic barriers exacerbated by misinformation and logistical inefficiencies. To address these challenges, public health initiatives must focus on improving accessibility, prioritizing high-risk groups, and building trust through culturally competent communication.

3.2.3.3 Telemedicine and the Digital Divide

Telemedicine emerged as a critical tool during the pandemic, enabling healthcare continuity amid social distancing measures. However, it also exposed and widened pre-existing digital divides.

Digital Barriers for Vulnerable Populations

Older adults faced significant challenges in accessing telehealth services, including unfamiliarity with digital tools and a preference for in-person care. In rural areas, inadequate internet infrastructure further limited access, leaving many patients unable to participate in virtual consultations. For example, in underserved regions, unreliable internet connectivity and lack of affordable devices prevented widespread telehealth adoption (Cole, 2021; Pasquinelli et al., 2022).

While telemedicine proved valuable, its uneven implementation highlighted systemic inequities. Addressing these gaps requires investments in broadband infrastructure, affordable technology, and digital literacy programs to bridge the divide and ensure healthcare accessibility for all.

3.2.3.4 Geographical Disparities

The COVID-19 pandemic's impact varied significantly across geographic regions, influenced by differences in healthcare infrastructure, socioeconomic factors, and public health responses.

Rural and Urban Divide

The COVID-19 pandemic revealed stark disparities in health outcomes and resource access between rural and urban areas. Rural regions experienced higher COVID-19 prevalence relative to population size, driven by limited healthcare infrastructure, fewer care facilities, and longer travel distances to access services. These systemic barriers compounded challenges for vulnerable rural populations, particularly those with chronic health conditions or limited mobility (Bambra et al., 2020; Bao et al., 2022).

In contrast, urban centers faced distinct challenges related to overcrowding, economic constraints, and concentrated poverty. Densely populated neighborhoods in metropolitan cities reported disproportionately high transmission rates, often correlated with socioeconomic and racial inequities. These disparities were exacerbated by the economic strain of the pandemic, which disproportionately affected minority communities in urban areas (Bao et al., 2022).

Social Vulnerability and Minority Populations

Counties with high minority populations reported elevated infection and mortality rates, driven by structural inequities such as income inequality, limited healthcare access, and systemic racism. These vulnerabilities underscored the need for tailored public health interventions that address the specific needs of marginalized communities. Minority populations in both rural and urban areas faced compounded risks due to their overrepresentation in essential worker roles and limited access to preventive healthcare services (Guo et al., 2021; Meng, 2023).

The uneven adoption of telemedicine further highlighted geographic and socioeconomic divides. While urban centers benefited significantly from advancements in virtual healthcare, rural areas lagged behind due to inadequate broadband access, high costs of digital devices, and lower digital literacy. These technological disparities limited the ability of rural residents to engage with telemedicine solutions, leaving many without access to essential healthcare services during the pandemic (Bartolomeo et al., 2022)

The interplay of geographic, socioeconomic, and racial disparities underscores the need for tailored public health interventions. Expanding rural healthcare infrastructure, addressing systemic inequities in urban areas, and implementing culturally sensitive outreach programs for minority populations are critical. Long-term investments in both physical and digital healthcare resources can bridge these divides and ensure resilience in future health crises.

3.2.3.5 Eviction and Homelessness

The COVID-19 pandemic highlighted the cascading risks of housing instability, with overcrowding linked to amplified transmission of infectious diseases. Stressors like anxiety, depression, and reduced access to healthcare weakened immune responses, further exacerbating vulnerabilities to COVID-19 (Benfer et al., 2021; Ahillan et al., 2023).

Demographics of Vulnerability

Persons of colour and individuals with pre-existing conditions, such as diabetes and pulmonary disease, were disproportionately affected by eviction and homelessness during the pandemic. Historical patterns of racial and economic disparities were amplified, with Black and Latinx populations facing heightened eviction rates and severe COVID-19 outcomes (Benfer et al., 2021).

Vaccine Hesitancy in Displaced Populations

Displaced populations, including refugees and asylum seekers, exhibited vaccine hesitancy influenced by misinformation and low health literacy. Immediate survival often took precedence over vaccination, highlighting unique challenges in addressing healthcare access and equity within these groups (Ahillan et al., 2023).

Mortality Among Homeless Populations

The mortality rate from COVID-19 among people experiencing homelessness was nearly double that of the general population, as seen in regions like Los Angeles. This stark statistic underscores the critical need to address health inequities exacerbated by housing insecurity (Chang et al., 2022).

Housing insecurity, homelessness, and the risks and impacts of eviction all affected the risk and severity of increased inequality related to the pandemic.

3.2.3.6 Correctional Facilities

The pandemic highlighted the vulnerability of correctional facilities, where overcrowded and unsanitary conditions created ideal environments for virus transmission. These factors amplified the health risks for inmates, who often entered the system with poor baseline health, resulting in severe outbreaks (LeMasters et al., 2022).

Structural Factors and Mass Incarceration

Mass incarceration in the United States contributed significantly to the pandemic's impact on incarcerated populations. Correctional facilities typically lacked robust virus mitigation measures, and congregate living conditions increased the prevalence of severe COVID-19 cases, exacerbating existing health inequities (LeMasters et al., 2022).

Racial Disparities in Incarceration

Incarceration disproportionately affects racialized communities, particularly Black, Native American, and Latinx populations. These groups, often from areas with systemic poverty and reduced healthcare access, faced compounded vulnerabilities in correctional settings during the pandemic (LeMasters et al., 2022).

Jail-Community Cycling and Broader Public Health Impacts

The movement of individuals between jails and their communities, known as "jail-community cycling," emerged as a significant driver of COVID-19 transmission. For example, studies in Illinois revealed that patterns of cycling from Cook County Jail predicted higher case rates in surrounding areas, emphasizing the interconnectedness of correctional and community health (Reinhart & Chen, 2020).

In these ways, the COVID-19 pandemic revealed the distinct challenges faced by incarcerated populations and highlighted the need for closer examination of correctional facilities as environments that both reflect and influence public health trends.

3.2.3.7 Migration Status

The increased and rapid movement of people around the globe, particularly of those seeking asylum or refugee status, produces and intensifies inequalities suffered by these populations, including those resulting from the way they were impacted by the pandemic.

Exclusion from Government Support Measures

Temporary migrants and undocumented workers faced distinct challenges during the pandemic due to their exclusion from government assistance programs. In Australia, temporary migrants were denied access to support schemes like the job keeper payment, forcing many into precarious employment to meet basic needs such as food and shelter. This economic exclusion also led to crowded living conditions, making it difficult to adhere to self-isolation measures and increasing the risk of virus transmission. The first lockdown exacerbated these vulnerabilities, emphasizing the link between economic support, housing stability, and public health outcomes (Ullah & Harrigan, 2022).

Barriers to Healthcare and Mental Health Impacts

Undocumented migrants across Europe encountered significant barriers to healthcare, which resulted in higher hospitalization rates and more severe clinical outcomes compared to nationals. In Italy, these disparities underscored the need for inclusive health policies that cater to all residents, regardless of migration status. Refugees and migrants also faced substantial challenges in adhering to COVID-19 preventive measures, which were compounded by misinformation and low health literacy. These barriers contributed to increased psychological distress, with many individuals experiencing anxiety, depression, and feelings of alienation. The lack of accessible healthcare and the stigma associated with being a migrant further entrenched these inequities (Immordino et al., 2022a; Marchi et al., 2022).

Regional Variations in Migrant Challenges

The pandemic's impact on migrants varied across regions. In the United States, immigrants and refugees were disproportionately affected by limited access to healthcare, financial strain, and crowded living and working conditions. These factors, compounded by policy decisions that restricted access to health and social services, significantly heightened their vulnerability to the virus. In Canada, the intersection of immigrant and visible minority status revealed unique disparities in accessing emergency or urgent care services. These examples demonstrate how migration status intersected with systemic inequities to shape health outcomes during the pandemic (Rafieifar et al., 2021; Etowa et al., 2021).

Impacts on Displaced Populations

Displaced populations such as refugees and asylum seekers faced specific challenges. Vaccine hesitancy within these groups was influenced by misinformation and low health literacy, with many prioritizing immediate survival over preventive healthcare measures like vaccination. In Los Angeles, the mortality rate from COVID-19 among homeless individuals, including displaced migrants, was nearly double that of the general population, highlighting the severe consequences of housing and healthcare insecurity (Ahillan et al., 2023; Chang et al., 2022).

Broader Implications for Health Inequalities

The experiences of migrants and refugees during the pandemic illustrate the profound impact of socioeconomic, policy, and systemic healthcare factors on health outcomes. With contributing factors ranging from economic exclusion in Australia to overcrowded housing and limited healthcare access in Europe and North America, migration status was a significant determinant of health inequities. These findings emphasize the need for inclusive policies and support systems that address the unique challenges faced by migrant populations globally (Bojorquez-Chapela et al., 2021).

In conclusion, migration status significantly influenced the health and wellbeing of individuals during the COVID-19 pandemic, exacerbating pre-existing inequalities. Migrants, refugees, and asylum seekers encountered numerous barriers, including limited access to healthcare, economic support, and safe living conditions, leading to increased vulnerability to the virus and mental health issues. The pandemic underscored the importance of inclusive policies and support systems that address the unique challenges faced by migrant populations, as demonstrated across different regions.

3.2.4 The Macrosystems (societal and policy environments)

The macrosystem represents the broadest layer of the SEM, encompassing overarching cultural, social, and policy-related influences that shape the environments in which individuals and groups live (Bronfenbrenner, 1977; McLeroy et al., 1988). Unlike the more immediate settings of microsystems, the connections within mesosystems, or the organizational and structural contexts of exosystems, the macrosystem includes the fundamental social norms, ideologies, and economic conditions that indirectly impact everyone within a society. Two critical aspects of the macrosystem were particularly central to elucidating the COVID-19 pandemic's wide-ranging social effects: racial and ethnic disparities, including Indigenous status, and broader socioeconomic inequalities. These factors highlight long-standing social inequities that both shaped and were intensified by the pandemic, ultimately influencing health outcomes and deepening pre-existing disparities across communities.

3.2.4.1 Racial and Ethnic Disparities and Indigenous Status

The COVID-19 pandemic exposed and intensified existing health disparities among racial, ethnic, and Indigenous populations. These inequities, rooted in systemic social and structural barriers, significantly influenced health outcomes such as infection and mortality rates. Communities historically marginalized within healthcare and social systems—such as Indigenous, Black, Latinx, and other minority groups—faced unique challenges that compounded the pandemic's impact. These disparities underscored the critical need to address the systemic inequities that shape public health outcomes.

Health Outcomes Among Racial and Ethnic Minorities

Black and Latinx populations in the United States experienced particularly high COVID-19 mortality rates, especially among older adults. For instance, in New York City, Black and Latinx residents aged 65 and older accounted for more than half of COVID-19 deaths, while White residents of the same age group made up only 15.8%. This disparity was closely linked to a higher prevalence of underlying health conditions, such as diabetes and hypertension, compounded by socioeconomic barriers that limited healthcare access (Gonzales et al., 2021; Selden & Berdahl, 2020).

Historical mistrust of the healthcare system also influenced vaccine hesitancy within certain racial minority groups. In both the United States and the United Kingdom, concerns arose regarding the rapid development and perceived limited testing of COVID-19 vaccines, particularly on ethnic minorities. This hesitancy reflects a legacy of medical exploitation and systemic neglect, complicating efforts to improve vaccination rates in these communities (Ogueji et al., 2022).

Challenges Faced by Indigenous Populations

Indigenous populations faced distinct challenges during the pandemic, rooted in historical and structural inequities. Native American communities in the United States experienced disproportionately high rates of infection and mortality. Structural factors, such as limited healthcare access, language barriers, and substandard housing, exacerbated their vulnerabilities. For example, in Montana, American Indian/Alaska Native individuals faced mortality rates nearly four times higher than White individuals, highlighting the profound impact of systemic inequities on health outcomes (Foxworth et al., 2022; Williamson et al., 2021).

Globally, Indigenous Australians faced indirect health impacts, including disrupted healthcare access and worsened mental health outcomes. These challenges emphasized the global nature of systemic barriers that Indigenous populations face during public health crises (Follent et al., 2021).

Intersectional Disparities in Health Outcomes

Structural inequalities like residential segregation and poverty compounded the pandemic's impact on both racial and Indigenous populations. Counties in the United States with larger Black populations experienced elevated COVID-19 death rates tied to adverse social determinants of health. Similarly, hospitals in California serving predominantly Black populations faced heightened operational strain, while Indigenous populations worldwide contended with inadequate healthcare resources and systemic discrimination (Williamson et al., 2021; Levinson et al., 2022).

The overrepresentation of Black and Hispanic individuals in the incarcerated population further compounded their risks. Correctional facilities, such as Chicago's Cook County Jail, became hotspots for COVID-19 transmission, affecting both incarcerated individuals and surrounding communities. This dynamic illustrated how institutional environments can amplify disparities (Carson, 2021; LeMasters et al., 2022).

The pandemic highlighted the systemic inequities faced by racial, ethnic, and Indigenous populations, underscoring how deeply rooted social determinants of health shape public health outcomes. Addressing these disparities requires long-term investments in equitable healthcare systems, culturally sensitive outreach efforts, and policies that prioritize the unique needs of marginalized communities. Bridging these gaps is essential to fostering health equity and resilience in future crises.

3.2.4.2 Socioeconomic Inequalities and Health Outcomes

The COVID-19 pandemic exposed deep-rooted socioeconomic inequalities, revealing how social and economic conditions critically shaped health outcomes across populations. Socioeconomically disadvantaged groups, including low-income communities, single-parent households, non-native populations, and those employed in precarious jobs, were among the hardest hit.

Income Inequality and Pandemic Vulnerability

In Los Angeles, a study of SARS-CoV-2 test results demonstrated that lower household incomes, higher unemployment rates, and inadequate health insurance coverage were significantly associated with higher positivity rates, particularly among Hispanic communities. These findings underscored the existence of stark differences in pandemic vulnerability based on income and employment stability (Allan-Blitz et al., 2021).

Gender and Household Composition

In addition to income-related disparities, other socioeconomic factors compounded pandemic effects. Gender and household composition played crucial roles, especially in North America, where women, many of whom are single parents or caregivers, faced amplified economic burdens due to disrupted childcare and increased household responsibilities. This dynamic exacerbated existing gender-based inequalities in employment and income, leading to poorer mental health outcomes and financial insecurity among female-led households (Vilar-Compte et al., 2022). Similarly, in Latin America, households with lower educational attainment or young children faced worsened economic outcomes, further revealing how socioeconomic and demographic factors combined to shape the pandemic experience (Vilar-Compte et al., 2022).

Crowded Living Conditions and Immigration Status

Crowded living conditions and immigration status also emerged as critical factors affecting health outcomes. In Milan, Italy, a cross-sectional study found that non-Italians were over twice as likely to test positive for COVID-19 compared to Italians, with older adults, those in crowded housing, and individuals with lower educational levels facing particularly high infection rates. This disparity highlights how conditions associated with lower socioeconomic status, such as dense housing and lack of educational opportunities, intersected to heighten risks in marginalized communities (Pagani et al., 2021).

Economic Constraints and Preventive Behaviours

Economic constraints further affected access to essential resources like personal protective equipment and cleaning supplies. Obtaining these necessities was disproportionately burdensome for low-income families. The elevated costs of these items limited the ability of financially constrained households to follow public health measures, placing them at higher risk for infection. In Hong Kong, for instance, low-income families reported difficulties in affording necessary protective materials, which affected their adherence to preventive behaviours and increased their exposure to COVID-19 (Siu, 2021).

Global Impact of Socioeconomic Inequalities

Globally, countries such as Mexico, Chile, and the U.S. documented evidence that lower socioeconomic status consistently correlated with poorer health outcomes during the pandemic. Socioeconomically vulnerable groups were more likely to experience higher infection rates, reduced access to healthcare, and increased mortality, underscoring the profound link between social determinants and health disparities during a public health crisis (Mena et al., 2021).

These findings offer a descriptive snapshot of how socioeconomic inequalities influenced health outcomes during the COVID-19 pandemic. The diverse challenges faced by low-income groups, single-parent households, immigrants, and those in precarious living situations reveal the multifaceted ways that social determinants of health exacerbated pandemic vulnerabilities and shaped distinct experiences across populations (Green et al., 2021).

3.2.5 Chronosystem: Temporal Dimension of Each of the Four Systems

The chronosystem within the SEM introduces a temporal dimension that threads through each level of the system—micro, meso, exo, and macro (Ornstein & Caruso, 2024). This dimension allows us to capture the evolution of the pandemic's impact over time, highlighting how changes and events unfold and interact across these levels. By focusing on this dynamic temporal interplay, we can better understand how various factors synergistically exacerbated health inequalities, creating what is described as a syndemic (Hossain et al., 2022; Mendenhall et al., 2022). The chronosystem thus emphasizes the importance of considering historical context and the progression of impacts over time in shaping public health responses.

The chronosystem considers the timing of influences and transitions in an individual's life that may coincide with broader historical changes, such as the COVID-19 pandemic. This temporal perspective underscores the significance of historical context and the progression of time in understanding the pandemic's impact on health disparities. Within this framework, we observe how pre-existing inequalities, shaped by past policies and social norms, were exacerbated and intensified by the crisis (Rajkumar et al., 2022).

Historically marginalized communities have endured long-standing health inequities that are intricately tied to the chronosystems in which they are embedded and that were exacerbated by the pandemic (Allan-Blitz et al., 2021; Gonzales et al., 2021). The chronosystem perspective reveals how the initial absence of healthcare infrastructure and social support for these populations set the stage for the heightened impact of COVID-19. Over time, as the pandemic progressed, these communities faced cumulative adversities, including increased exposure to the virus, limited access to testing and treatment, and compounded socioeconomic challenges (Allan-Blitz et al., 2021; Gonzales et al., 2021).

The timing of policy responses and public health measures, varying greatly between regions and influenced by social, political, and economic factors, also falls under the chronosystem's purview (Cash-Gibson et al., 2021; Painter et al., 2024). The disparities in the timing of these responses played a crucial role in mitigating or exacerbating health inequalities. For example, delays in implementing social distancing measures or rolling out vaccinations had a ripple effect, amplifying adverse outcomes for already vulnerable groups.

In addition, the chronosystem captures the historical moment of the pandemic's intersection with significant social movements. The resurgence of social justice movements like Black Lives Matter during the pandemic period brought to light the critical nexus between social activism and public health (Rohlinger & Meyer, 2024). This confluence of events presented a unique opportunity to leverage the momentum for social change to address health inequities in a more comprehensive and transformative manner.

As we reflect on the temporal dimension of health inequalities during COVID-19, we recognize the imperative of timing in interventions. Early, targeted, and culturally sensitive responses are vital to preventing the deepening of disparities. Moreover, the chronosystem reminds us of the potential long-term impacts of the pandemic, such as the lasting effects on mental health, the workforce, and education systems, which may unfold over the coming years.

In integrating the chronosystem into our understanding of the syndemic nature of COVID-19, we acknowledge the importance of historical context, the significance of timing in public health responses, and the long-term implications of the pandemic on health inequalities. The temporal dimension provides a reminder that in addressing the COVID-19 crisis and preparing for future pandemics, we must consider past lessons, present urgencies, and future implications. Only by acknowledging the temporal context can we hope to craft interventions that are as resilient and enduring as the societies we aim to protect and uplift.

The chronosystem, therefore, must be considered both when looking at how existing health inequalities interacted with the pandemic and at how the syndemic conditions produced by these inequalities during COVID-19, did not play out in a contextual vacuum. Context, history, and public policies all meet at particular social (and epidemiological) conjunctures to interact in specific, and in many cases, negative, ways.

4 CONCLUSION

4.1 Syndemic Interactions of COVID-19

This report presents a socio-ecological analysis that elucidates the syndemic interactions of COVID-19, delineating how multifactorial elements coalesced to amplify health inequalities during the pandemic. Central to the findings is the SEM, which serves as a foundational framework for unpacking the intricate layers, from the microsystem to the macrosystem, through which the virus disproportionately impacted vulnerable populations. Including the chronosystem underscores the pandemic's temporal dynamics and the evolution of its syndemic nature.

4.2 Multi-Level Impact of COVID-19

Our synthesis of the literature highlights the pervasive nature of COVID-19 as it transcends the micro-level personal experiences and reverberates through the meso, exo, and macro-levels, shaping and being shaped by broader social structures and policies. At the microsystem level, COVID-19 targeted vulnerabilities inherent to age, chronic diseases, disabilities, and educational inequalities. The intersectionality of these factors with mental health and substance use further complicates the microsystem's role in influencing health outcomes during the pandemic. These personal interactions and experiences set the immediate context within which individuals navigated the pandemic, often with limited resources and support.

At the mesosystem level, evidence of the pandemic's toll is found in gender-based disparities and challenges faced by the 2SLGBTQI+ community, reflecting the exacerbation of pre-existing inequalities arising from social norms and diminished access to critical healthcare services. The exosystem adds another layer, highlighting the influence of broader social structures, including healthcare and policy disparities that critically shaped access to care, vaccination equity, and broader public health measures.

The macrosystem's role was particularly pronounced, revealing deep-seated racial and ethnic disparities and Indigenous status inequities. At this level, systemic issues such as historical neglect, underinvestment in healthcare, and socioeconomic marginalization converged, setting the stage for a stark contrast in COVID-19's impact across different communities.

4.3 Policy Interventions and Strategies

Informed by the SEM, our report underscores the need for policy interventions that account for the layered nature of health disparities. The pandemic issued a clarion call for policies that are reactive to emergent health crises and proactive in addressing the underlying social determinants of health that contribute to disparities. It is incumbent upon health systems, policymakers, and community leaders to forge targeted strategies that mitigate the effects of systemic racism, enhance healthcare accessibility, and bridge the digital divide, ensuring that no community is left behind in times of crisis.

Moreover, the results advocate for culturally sensitive and inclusive policies that accommodate the unique needs of diverse populations, recognizing the particular challenges faced by the elderly, individuals with chronic illnesses, and marginalized communities such as racial minorities and 2SLGBTQI+ groups.

4.4 The Role of the Chronosystem

Acknowledging the chronosystem's role is critical to understanding the lasting implications of COVID-19. The temporal aspect of the pandemic's impact calls attention to the importance of considering how past inequities inform present challenges and future vulnerabilities. It calls for a sustained commitment to structural reforms that extend beyond the immediacy of the pandemic and aim to fortify communities against future syndemics.

This approach must recognize the potential for historical moments of crisis to bring about transformative change. Social movements, which gained momentum during the pandemic, presented opportunities to catalyze reforms in public health and beyond. As the world looks to emerge from the shadow of COVID-19, the chronosystem serves as a reminder of the urgency of incorporating the lessons learned into a concerted effort to rebuild more equitable and resilient societies.

4.5 The Need for Multifaceted Interventions

The SEM and the evidence gathered throughout the pandemic highlights the need for multifaceted, multilevel interventions in the context of health crises. Such interventions should be rooted in an understanding of the complex interactions between individual behaviours, interpersonal relationships, community contexts, and social structures that influence health outcomes. Strategies should be tailored to addressing the nuanced needs of various groups, informed by a comprehensive analysis of the social determinants of health, and implemented with foresight that considers the long-term syndemic interactions of health disparities.

4.6 Future Research

While this report synthesizes current knowledge, it also underscores gaps requiring further exploration. Future research should aim to deepen the understanding of syndemic interactions in diverse contexts and evaluate the long-term impacts of multifaceted public health strategies implemented during the pandemic. It should also strive to develop predictive models to better prepare for and respond to future public health crises, emphasizing equity and social justice.

Our analysis has shown that the syndemic nature of the COVID-19 pandemic necessitated a comprehensive, multi-level, and culturally sensitive response. As we move forward, the lessons learned during this crisis should inform a public health paradigm prepared to effectively address the immediate and long-term effects of pandemics, rooted in a deep understanding of the socio-ecological dimensions of health inequalities.

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APPENDIX 1 METHODOLOGY

Study Design

As this work was intended to gather and synthesize specific evidence in line with our aims, we used a purposive literature review (Cook, 2019). A purposive literature review allows for a focused and strategic selection of sources and papers directly relevant to the research questions, ensuring a thorough exploration of the syndemic impacts of COVID-19 on health inequalities (Cook, 2019; Mendenhall et al., 2022). This method facilitates the identification of key themes, levels, and dimensions within the existing body of literature, enabling a targeted approach to synthesizing evidence that may inform policy making in the future. By concentrating on three specific aspects; the COVID-19 pandemic, health inequalities, and policy measures, the review efficiently harnesses critical insights from a vast array of studies, maximizing relevance and applicability to the research objectives.

Search Strategy and Selection Criteria

In March 2023, we performed a systematic search on Ovid MEDLINE, Health Policy Reference Center, Political Science Complete, Public Affairs Index and SocINDEX. MESH terms or other associated terms for COVID-19 cross-referenced with 'Health inequalities,' 'Health inequities,' 'Health disparities,' 'Disadvantaged populations,' 'Vulnerable groups,' 'Underserved populations,' 'Policy,' 'Measures,' 'Interventions' and 'Action plan' were used. The selection criteria are listed in Table 1.

Table 1 Criteria for Selecting and Including Studies

Selection and eligibility criteria		
	Inclusion	**Exclusion**
Studies	Peer-reviewed articles. Qualitative, quantitative, and mixed-methods studies. Reviews, opinion pieces, and commentaries that provide insight into or perspectives on the topic. Country or region-specific case studies.	Studies not relevant to the topic of health inequalities and the impact of the pandemic. Duplicate studies or multiple publications of the same dataset unless new perspectives are brought.
Population and location	Disadvantaged populations in OECD countries, which may include but is not limited to: Socioeconomically deprived groups. Racial and ethnic minorities. Refugees and displaced individuals. Homeless populations. Individuals with pre-existing health conditions.	Studies that focus on advantaged or non-disadvantaged populations without any comparative analysis and conducted outside of OECD countries. Studies that do not specify the population or demographics being studied.
Key variables and topics of interest	Direct and indirect health impacts of the COVID-19 pandemic. Access to healthcare services during the pandemic. Socioeconomic factors contributing to increased vulnerability. Mental health outcomes. Disparities in vaccine distribution or access. Experiences and narratives from these disadvantaged groups.	Articles that solely focus on clinical manifestations and treatment of COVID-19 without any relation to health inequalities. Studies that are purely biological or molecular in nature without any socio-economic or health inequality context.
Timeframe	Studies conducted between the beginning of the pandemic (end of 2019) and April 2023.	Studies conducted before the COVID-19 pandemic and after the data collection time frame.
Language	Articles written in English and French or that have an English or French translation available.	Articles with no English or French version or translation available.

Screening

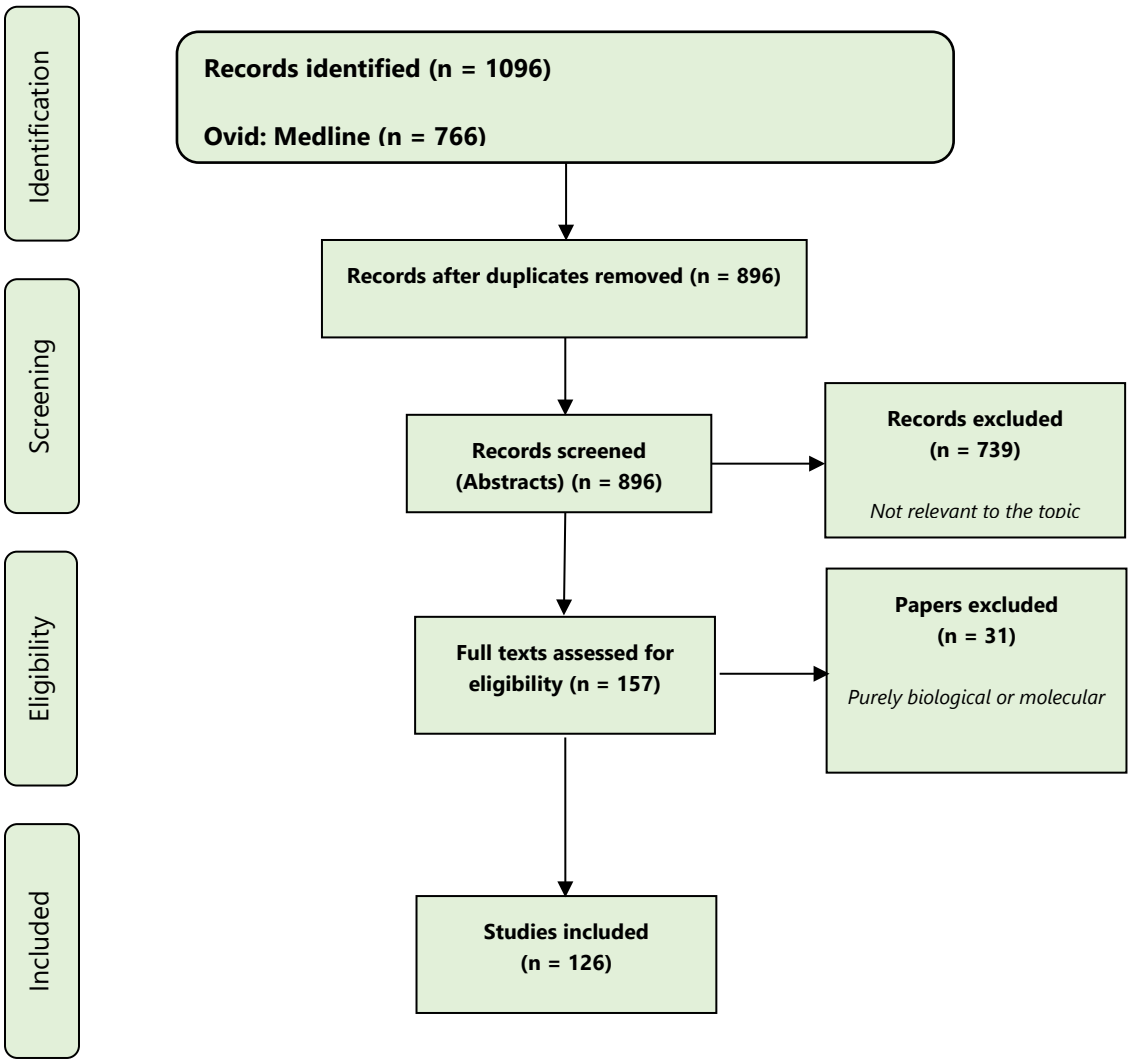
Two reviewers screened each paper at the title and abstract (n=1096 articles) and full-text (n=157 articles) review stages. All papers coded as potentially relevant were included in the next stage of the review process. If only one reviewer coded an article as potentially relevant during abstract screening, the review team included that entry for full-text review for increased sensitivity. After a full-text review, discrepancies between reviewers regarding inclusion for data abstraction were resolved through discussions until a consensus was reached. Finally, 126 studies were included in this review. Standardized Excel forms were piloted and used for data abstraction. The data abstraction form included information about the date of publication, study design and type (single study or synthesis), country or region of study, levels of the SEM, dimensions of health inequalities and summary findings.

Data Extraction and Analysis

The classification of the dimensions of health inequalities in the context of COVID-19 was done using the socio-ecological framework (Bronfenbrenner, 1977). As illustrated in Figure 1 (the SEM levels with corresponding dimensions of health inequalities indicated here or at the beginning of the results section), the first level identified individual dimensions constituting the microsystems: age-related disparities, chronic diseases and disabilities, educational inequalities, mental health, and substance use and health disparities. Interpersonal dimensions such as gender-based disparities and sexual orientation constitute the mesosystems. The third dimension is the exosystem, which includes access to healthcare, geographical disparities, eviction and homelessness, migration status, and vaccination inequity. Racial and ethnic disparities and Indigenous status, socioeconomic inequalities and correctional health constitute the macrosystems. Finally, the chronosystem analyses the temporal dimension of each of the four previous systems.

Data were checked for inconsistency and cleaned. Analysis was conducted qualitatively from the summary findings after extracting relevant parts from each paper (Figure 2, PRISMA flow diagram). The qualitative analysis was performed by synthesizing the findings extracted from each selected paper. This process involved a careful review of the extracted data to identify common themes, patterns, and insights related to each of the dimensions of health inequalities and corresponding levels of the SEM. By summarizing these findings, the analysis aimed to distill critical evidence and perspectives on how the pandemic exacerbated health inequalities across different populations and settings. This approach allowed us to integrate diverse viewpoints and empirical data into a coherent narrative highlighting the multifaceted nature of health inequalities during the pandemic, providing a solid foundation for future targeted interventions and policy recommendations.

Figure 2 PRISMA Flow Diagram Illustrating the Study Selection Process



Limitations

Our literature review was confined to studies published in English and French, potentially excluding relevant research in other languages and introducing a language bias. Additionally, although comprehensive, our search strategy may not have captured all relevant literature not indexed in the databases searched. The review focused on literature available up to April 2023, potentially missing relevant studies published after this date that could further inform the research.

Furthermore, despite rigorous screening and selection criteria, the subjective nature of study selection could introduce bias, affecting the generalizability of findings. Reliance on standardized Excel forms for data abstraction assumes uniformity in reporting across studies, which may not account for the nuances of each study's methodology or findings.

Finally, we did not perform a formal quality assessment process for the included studies. Thus, our review may consist of studies with varying levels of methodological quality, potentially affecting the overall interpretation and conclusions drawn.

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